Attachment H 6/1026

COVER SHEET (PAGE 1 of 2)

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Proposal Title: Merced River Corridor Restoration Plan

Applicant Name: Stillwater Sciences & Merced Co. Planning & Comm. Develp. Dept.

Mailing Address: 2532 Durant Ave, Suite 201, Berkeley CA 94704

Telephone: (510) 848-8098

Fax: (510) 848-8398

Amount of funding requested: (II/III)482,252 for 2 years

(I) $26,552

Indicate the Topic for which you are applying (check only one box). Note that this is an important decision: see page __ of the Proposal Solicitation Package for more information.

- ☐ Fish Passage Assessment
- ☐ Fish Passage Improvements
- ☐ Floodplain and Habitat Restoration
- ☐ Gravel Restoration
- ☐ Fish Harvest
- ☐ Species Life History Studies
- ☒ Watershed Planning/Implementation
- ☐ Education
- ☐ Fish Screen Evaluations - Alternatives and Biological Priorities

Indicate the geographic area of your proposal (check only one box):

- ☐ Sacramento River Mainstem
- ☐ Sacramento Tributary: _____
- ☐ Delta
- ☐ East Side Delta Tributary: _____
- ☐ Suisun Marsh and Bay
- ☒ San Joaquin Tributary: Merced River
- ☐ San Joaquin River Mainstem
- ☐ Other: _____
- ☐ Landscape (entire Bay-Delta watershed)
- ☐ North Bay: _____

Indicate the primary species which the proposal addresses (check no more than two boxes):

- ☒ San Joaquin and East-side Delta tributaries fall-run chinook salmon
- ☐ Winter-run chinook salmon
- ☐ Spring-run chinook salmon
- ☐ Late-fall run chinook salmon
- ☐ Fall-run chinook salmon
- ☐ Delta smelt
- ☐ Longfin smelt
- ☐ Splittail
- ☐ Steelhead trout
- ☐ Green sturgeon
- ☐ Striped bass
- ☒ Migratory birds

May 1998 CALFED ECOSYSTEM RESTORATION PROPOSAL SOLICITATION

Indicate the type of applicant (check only one box):

☐	State agency	☐	Federal agency
☐	Public/Non-profit joint venture	☐	Non-profit
☒	Local government/district	☒	Private party
☐	University	☐	Other: _____

Indicate the type of project (check only one box):

☒	Planning	☐	Implementation
☐	Monitoring	☐	Education
☐	Research		

By signing below, the applicant declares the following:

(1) the truthfulness of all representations in their proposal;

(2) the individual signing the form is entitled to submit the application on behalf of the applicant (if applicant is an entity or organization); and

(3) the person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section II.K) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

(Signature of Applicant)

I-011228

EXECUTIVE SUMMARY

PROJECT TITLE: **MERCED RIVER CORRIDOR RESTORATION PLAN**

APPLICANTS: **Stillwater Sciences and Merced County Planning and Community Development Department**

PROJECT DESCRIPTION AND PRIMARY BIOLOGICAL/ECOLOGICAL OBJECTIVES: The goal of this project is to develop a public-supported, technically sound, and implementable restoration plan for the Merced River corridor from Crocker-Huffman Dam (RM 52) downstream to the San Joaquin River (RM 0). The plan will focus on reestablishing geomorphic and ecological functions, processes, and characteristics given contemporary regulated flow and sediment conditions in the Merced River to reverse long-term trends of degradation and improve habitats from existing conditions. This project will be implemented in three phases: (I) establish a Merced River Stakeholder Group and Technical Advisory Committee (TAC), (II) analyze and quantify current in-channel, riparian, and floodplain conditions and processes, and (III) synthesize input from the Stakeholder Group and TAC (Phase I) and results of the geomorphic and ecological analysis (Phase II) to develop a Merced River corridor restoration and monitoring plan. Phase I will continue throughout Phases II and III of the project. This phase will likely be funded by the Anadromous Fisheries Restoration Program (AFRP). A final funding decision is anticipated in July 1998. **This proposal seeks funding for Phase II, Phase III and, in the event that AFRP funding is not approved, Phase I.**

APPROACH, TASKS, AND SCHEDULE: Public and stakeholder support and participation will provide a foundation for this project. The Merced County Planning and Community Development Department is convening a Stakeholder Group and a Technical Advisory Committee (TAC). The Stakeholder Group will represent a broad array of public and private interests, providing a barometer of issues and concerns. The TAC will provide input on study designs, data interpretation, and development and prioritization of restoration approaches giving consideration to the issues and concerns identified by the Stakeholder Group. In addition, three public workshops will be conducted.

Developing the restoration plan will require an understanding of existing physical and ecological conditions and processes in the corridor and of how these conditions and processes can be improved within existing physical, social, institutional, and infrastructural constraints. Phase II of the project includes the following tasks: (1) identify social, institutional, infrastructural and legislative opportunities and constraints; (2) develop a current, georeferenced map of channel and floodplain information; (3) develop a quantitative understanding of hydrology, channel morphology, and sediment supply and transport; (4) assess floodway constriction by levees and agricultural/urban encroachment; (5) assess and map current riparian vegetation and wetlands; (6) integrate biological information from California Department of Fish and Game and Merced Irrigation District studies; and (7) identify and predict geomorphically functional channel and floodplain morphology. These baseline evaluations will incorporate continuing input from the Stakeholder Group and TAC. The information collected will provide a foundation for definition of issues and restoration needs by these groups.

Phase III focuses on synthesizing information developed in Phase II to develop a Merced River corridor restoration and monitoring plan. During this phase, the Project Team will work closely with the Stakeholder Group and TAC to develop a restoration vision for the Merced River corridor, identify and prioritize restoration actions, and develop funding proposals for five of the highest priority restoration projects.

Peer review of study designs and analyses and restoration and monitoring recommendations will

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be provided by a Scientific Advisory Team, consisting of internationally recognized experts in the fields of geomorphology, hydrology, aquatic and riparian ecology, and statistics.

Anticipated completion time is 22 months.

JUSTIFICATION FOR PROJECT AND FUNDING BY CALFED: The Merced River sediment supply, flow regime, and floodway and channel morphology have been significantly altered, resulting in loss and degradation of habitat for native species, particularly chinook salmon. Despite general recognition of the degraded condition of the Merced River, no long-term restoration strategy has been developed for the Merced River corridor. This project proposes to develop a long-term, large-scale restoration and monitoring program that will identify and restore critical geomorphic and ecological processes that create and maintain healthy riverine ecosystems. Such a strategy will ensure the continuing long-term effectiveness of site-specific restoration projects and provide long-term benefits to ecosystem processes, riverine habitats, and native species.

BUDGET COSTS AND THIRD PARTY IMPACTS: The estimated total cost of Phases II and III of the project is $482,252. The estimated cost of Phase I is $26,552. Funding for this phase is anticipated to be provided by AFRP.

The proposal includes coordination with stakeholders, agencies, and the public to ensure that all potential third party impacts are identified and avoided.

APPLICANT QUALIFICATIONS: The Project Team is composed of the Merced County Planning and Community Development Department and three consulting firms specializing in geomorphic and ecological analyses and public coordination and having experience in design and implementation of restoration projects in the San Joaquin Basin. The project team also includes a Scientific Advisory Team, as described above.

MONITORING AND DATA EVALUATION: The restoration plan will include river-wide and project-specific monitoring programs to evaluate the effectiveness of proposed restoration actions. The Project Team is experienced in developing focused, cost-effective and scientifically sound monitoring programs for stream restoration projects, integrated natural resource management plans, and habitat conservation plans. McBain and Trush and Stillwater Sciences are currently working to develop and implement long-term monitoring on the Tuolumne River.

LOCAL SUPPORT/COORDINATION WITH OTHER PROGRAMS/COMPATIBILITY WITH CALFED OBJECTIVES: This project will provide baseline information and restoration strategies to address ERPP Implementation Objectives related to restoration of hydraulic conditions, sediment regimes, and channel, riparian and floodplain conditions necessary to reestablish geomorphic processes and create and sustain habitat for fish, wildlife, and plant communities. The Project Team has coordinated closely with Merced Irrigation Disitrict and their fisheries consultant to develop a study approach that complements their 10-year aquatic resources study program, allows for mutual, collaborative feedback, and provides a strong foundation for restoring ecological and geomorphic processes in the Merced River corridor.

MERCED RIVER CORRIDOR RESTORATION PLAN

JOINT VENTURE

Company/Agency	**STILLWATER SCIENCES**	**MERCED COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT**
Address	2532 Durant Avenue Berkeley, CA. 94704	2222 M Street Merced, CA. 95340
Phone	(510) 848-8098	(209) 385-7654
Fax	(510) 848-8398	(209) 726-1710
E-mail	jen@stillwatersci.com	
Contact	**Jennifer Vick**	**Bob Smith, Director**
Type of Organization/ Tax Status	Incorporated/Small Business	Local Government
Tax Identification No.	94-3241861	

SUBCONSULTANTS

Company	**MCBAIN AND TRUSH**
Address	P.O. Box 663 Arcata, CA. 95521
Phone	(707) 826-7794
Fax	(707) 826-7795
E-mail	mcbtrsh@northcoast.com
Contact	Scott McBain
Type of Organization/ Tax Status	Partnership/Small Business
Tax Identification No.	68-0347100

Company	**EDAW**
Address	753 Davis Street San Francisco, CA 94111
Phone	(415) 433-1484
Fax	(415) 788-4875
E-mail	digennarob@edaw.com
Contact	Bruce DiGennaro
Type of Organization/ Tax Status	Incorporated
Tax Identification No.	94-1641716

Participants/Collaborators in Implementation: The Project Team will collaborate with the Merced River Stakeholder Group and Technical Advisory Committee, which will include representatives from CDFG, CDWR, Merced Irrigation District, Merced County Association of Governments, local landowners and business interests, and other stakeholders. We have also coordinated closely with MID, CDFG, AFRP, and CDWR during the preparation of this proposal.

PROJECT DESCRIPTION

A. PROJECT DESCRIPTION AND APPROACH: The goal of this project is to develop a public-supported, technically sound, and implementable restoration plan for the Merced River corridor from Crocker-Huffman Dam (RM 52) downstream to the San Joaquin River (RM 0). The plan will focus on reestablishing geomorphic and ecological functions, processes, and characteristics given contemporary regulated flow and sediment conditions in the Merced River to reverse long-term trends of degradation and improve habitats from existing conditions. The plan will be based on the model illustrated in Figure 1, in which geomorphic processes (governed primarily by sediment supply and streamflow) determine the quality, quantity, and distribution of physical habitat. It will build on work already completed by members of the Project Team on the Merced and Tuolumne rivers (Vick 1995; Kondolf et al. 1996a, 1996b; McBain and Trush, 1998; see EA Tuolumne River Study Bibliography Appendix B) as well as studies conducted for the California Department of Fish and Game (CDWR 1994; JSA 1995; WEST Consultants 1995; USFWS 1997). This project will be implemented in three phases: (I) establish a Merced River Stakeholder Group and Technical Advisory Committee (TAC), (II) analyze and quantify current in-channel, riparian, and floodplain conditions and processes, and (III) synthesize input from the Stakeholder Group and TAC (Phase I) and results of the geomorphic and ecological analyses (Phase II) to develop a Merced River corridor restoration and monitoring plan. Phase I will continue throughout Phases II and III of the project. Phase I will likely be funded by the Anadromous Fisheries Restoration Program (AFRP). A final funding decision is anticipated in July 1998. **Phase I is included in this CALFED proposal in the event that the AFRP does not provide funding. If Phase I is funded by the AFRP, this proposal seeks funding for Phases II and III only.**

Public and stakeholder support and ownership of the final restoration plan will provide a foundation for this project. The Merced County Planning and Community Development Department is convening a Stakeholder Group and a Technical Advisory Committee (Figure 2). The Stakeholder Group will represent a broad array of public interests, providing a barometer of issues and concerns. The TAC will provide input on study designs, data interpretation, and development and prioritization of restoration and monitoring approaches giving consideration to the issues and concerns identified by the Stakeholder Group. These groups will meet regularly at project milestones to receive information from the Project Team and to provide input and guidance on future tasks (see Schedule – Section V(b)). The Merced County Planning and Community Development Department has applied for $26,552 from the Anadromous Fisheries Restoration Program to convene and administer these groups and anticipates hosting, in cooperation with the Merced Irrigation District, an inaugural open house in September 1998. In addition, three workshops intended to reach a broader public beyond the Stakeholder Group will be held at key milestones (see Schedule – Section V(b)).

Developing the restoration plan will require an understanding of existing physical and ecological conditions and processes in the Merced River corridor and of how these conditions and processes can be improved within existing physical, social, institutional, and infrastructural constraints. These components will be assessed in Phase II. The physical/ecological analyses will address historical and current hydrology, supply and transport of coarse and fine sediment, and floodplain and riparian habitat characteristics. The Project Team will meet with the Stakeholder Group and TAC early in the process to present proposed baseline study designs and receive input and, as studies progress, will continue to provide preliminary results to and receive input from these groups. Data analysis and presentation will be facilitated by the use of computer-based geographic information systems (GIS) and other current technologies.

Phase III focuses synthesizing information developed in Phase II and continuing input from the Stakeholder Group and Technical Advisory Committee to develop a Merced River corridor restoration

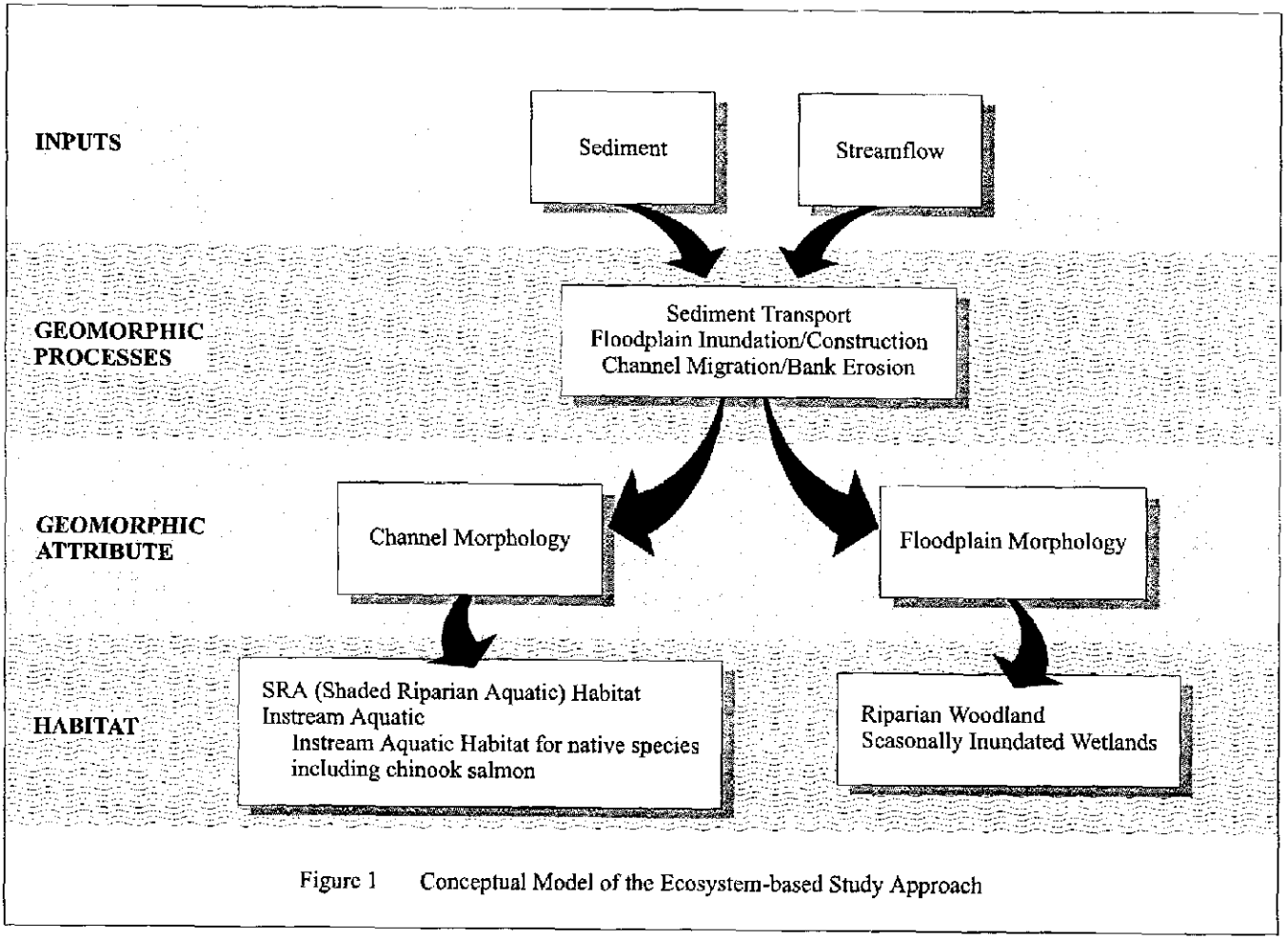

Figure 1 Conceptual Model of the Ecosystem-based Study Approach

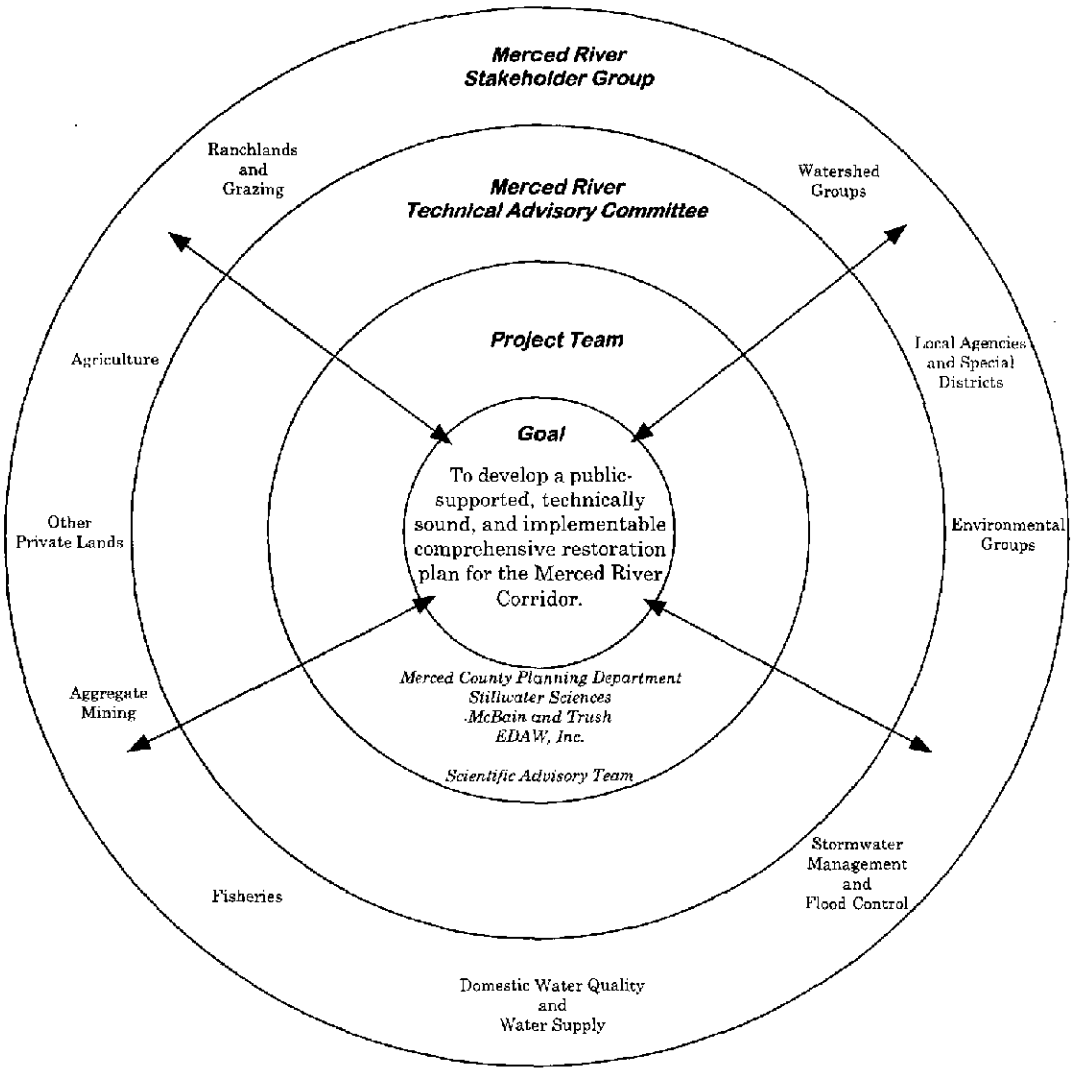

Figure 2. Merced River Stakeholder Group, Technical Advisory Committee, and Project Team Structure & Communication

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plan. During this phase, the Project Team will work closely with the Stakeholder Group and TAC to identify and prioritize restoration actions throughout the river corridor. Likely restoration actions may include (but are not limited to) channel and floodplain reconstruction, coarse sediment (spawning gravel) augmentation, and identification of key floodplain and riparian preservation and restoration sites. Once projects are identified, conceptual designs will be developed for the five top priority projects to jump-start their implementation.

Peer review of study designs and analyses and restoration recommendations will be provided by a Scientific Advisory Team, consisting of internationally recognized experts in the fields of geomorphology, hydrology, aquatic and riparian ecology, and statistics.

B. PROPOSED SCOPE OF WORK

PHASE I: ESTABLISH A MERCED RIVER STAKEHOLDER GROUP AND TECHNICAL ADVISORY COMMITTEE

Task 1: Establish a Merced River Stakeholder Group and Technical Advisory Committee. The Merced County Planning and Community Development Department will convene and administer a Stakeholder Group and TAC to provide input and guidance to development of the restoration and monitoring plan. Administering these groups will include: contacting agencies, stakeholders, and the general public to kick-off the process and convene interested participants; helping to define the groups' objectives and mission; setting meeting agendas; scheduling and chairing meetings; taking and distributing meeting minutes; providing a meeting place; and serving as a clearinghouse for Stakeholder and TAC correspondence and materials.

This task is proposed to be funded by AFRP. Funding will support Merced County Planning and Community Development Department costs and Stillwater Sciences participation in four Stakeholder Group meetings, ten Technical Advisory Committee meetings, and four site reconnaissance trips. The Stakeholder Group kick-off meeting is tentatively scheduled for September 1998. The Merced Irrigation District (MID) will co-host the initial meeting.

PHASE II: BASELINE EVALUATIONS

Task 1: Coordinate with the Merced River Stakeholder Group and Technical Advisory Committee. The Project Team will coordinate with the Stakeholder Group and the Technical Advisory Committee via regularly scheduled, milestone-oriented meetings (see Schedule – Section V(b)). Costs for Stillwater Sciences' role in this task are proposed to be funded by the AFRP. Additional funds for participation (as needed) by McBain and Trush and EDAW are included in this CALFED proposal.

Task 2: Identify Social, Institutional, and Infrastructure Opportunities and Constraints. Key factors affecting potential future restoration opportunities within the river corridor include land ownership patterns, existing land use and zoning, existing and planned aggregate mining activities and mineral reserve classifications, floodway conveyance and flood routing bottlenecks, and other factors. Opportunities and constraints associated with these factors will be identified for use in guiding baseline studies, developing appropriate restoration strategies, and assessing the feasibility of specific projects.

Task 3: Develop a Current, Georeferenced Map of Channel and Floodplain Conditions (New Exchequer Dam to the San Joaquin River). No up-to-date basemap of the Merced River is available, and the most recent aerial photographs of the river were taken in 1993, prior to the January 1997 flood,

which caused significant channel alteration. To develop a current map of channel and floodplain conditions, the Project Team will contract with an aerial photography firm to produce 1:6,000-scale, stereo photographs of the reach from New Exchequer Dam to the San Joaquin River confluence. The Project Team will orthorectify these photographs and create a GIS basemap that includes active channel boundaries, floodplain and terrace features (including levees), land ownership, and riffle locations.

Task 4: Develop a Quantitative Understanding of Hydrology, Channel Morphology, and Sediment Supply and Transport.

Tasks 4.1: Hydrologic Analysis. The Project Team will update existing hydrologic analyses to include recent data. This task will include: (1) a re-analysis of flood frequencies and magnitudes downstream of the Crocker-Huffman Dam near Snelling and at Stevinson and (2) an analysis of annual hydrograph components downstream of Crocker-Huffman Dam.

Task 4.2: Channel Surveys. Channel cross section and profile surveys are needed to document channel morphology and to provide data for sediment transport and hydraulic modeling. Cross sections and profiles will be surveyed in spring or summer 1999 (depending on flow conditions). Water surface profiles will be documented during high-flow events, if possible. The locations and distribution of these surveys will be determined based on modeling needs and reference site availability.

Task 4.3: Identify Major Sources of Fine Sediment and Assess the Effects of Fine Sediment on Ecosystem Processes and Habitat Quality. Increased fine sediment delivery to streams can have numerous deleterious ecological effects, including reduction of salmonid embryo survival when fine sediments infiltrate spawning gravels. The effects of fine sediment in the study reach will be assessed using field reconnaissance to qualitatively identify the size and quantity of fine sediment delivered to the study reach and fine sediment storage in the channel bed and floodplain. In addition, fine sediment and flow discharge of primary tributaries near Crocker-Huffman Dam will be sampled during at least one storm event to predict quantitative differences in fine sediment flux between them.

Task 4.4: Assess Coarse Sediment Supply and Transport, and Identify the Effects of Supply and Transport Conditions on Geomorphic and Ecological Processes. Coarse sediment supply and transport are key geomorphic processes that maintain channel morphology and bed material composition, both of which provide key habitats to aquatic organisms. The Project Team will (1) identify sources and estimate input rates of coarse sediment, (2) measure and predict coarse sediment transport and transport thresholds in the gravel-bedded reach, and (3) identify sediment traps in the channel that impede sediment transport continuity. Coarse sediment transport will be predicted based on a method developed by Wilcock (1996), which combines sediment transport modeling with empirical measurements. Provided that flood control releases occur in WY 1999, field measurements of sediment transport in the gravel-bedded reach will be conducted. Hydraulic parameters (slope, depth, area, particle size) will also be measured in the field during as many flows as possible (up to four).

Task 5: Assess Floodway Width and Conveyance from Crocker-Huffman Dam to the San Joaquin River. This task will include: (1) developing criteria for adequate floodplain width based on hydrologic, hydraulic, and ecological analyses; (2) identifying (from aerial photographs and maps) locations where the floodplain is narrower than this width; and (3) identifying where floodplain width could be increased within existing land use and land ownership constraints.

Task 6: Map Current Riparian Vegetation and Wetlands and Identify Relationships to Geomorphic Features and Processes (RM 55.5 to the San Joaquin River). Using aerial photograph interpretation and field verification, the Project Team will (1) identify losses of historic riparian and wetland habitat, (2) assess current riparian and wetland vegetation conditions, (3) identify and map (as a GIS layer) existing riparian vegetation types and their associations with key geomorphic units, and (4) identify and map (as a GIS layer) unique riparian and wetland wildlife habitats.

Task 7: Integrate Biological Information from CDFG and MID Studies to Assess Ecological Conditions. The California Department of Fish and Game (CDFG) and MID are planning to implement a 10-year study of Merced River chinook salmon population dynamics. This study is intended to provide information on constraints to chinook salmon survival and production in the Merced River. The biological information provided by the CDFG/MID study will be integrated into our geomorphic/ecological evaluations, which will in turn be tailored to complement the CDFG/MID studies. Recommendations to specifically address factors identified by the CDFG/MID study and complementary geomorphic/ecological studies will be included in the restoration plan.

Task 8: Develop Geomorphically Functional Channel and Floodplain Morphology Design Guidelines. At nearly all locations on the lower Merced River, the channel morphology has not equilibrated to flow- or land use-induced disturbances and is unlikely to do so under current sediment supply and flow conditions. Reconstructing channel and floodplain morphology in many locations is therefore required to restore a geomorphically functional riverine system. The Project Team will develop target dimensions for a geomorphically functional channel and floodplain morphology in the gravel-bedded reach, using a set of model reaches and the anticipated high-flow regime. Functional channel and floodplain morphology will be identified based on coarse sediment assessment (Phase II, Task 4.4) and reference reach surveys (Phase II, Task 4.2).

Task 9: Public Workshop. A public workshop will be held early in Phase II to provide information to the broader public beyond the Stakeholder Group.

PHASE III: THE MERCED RIVER CORRIDOR RESTORATION AND MONITORING PLAN

Task 1: Coordinate with the Merced River Stakeholder Group and Technical Advisory Committee. This task is a continuation of Phase II, Task 1, above.

Task 2: Develop the Merced River Corridor Restoration and Monitoring Plan: Based on input from the Stakeholder Group and TAC and the results of the baseline evaluations (Phase II), the Project Team will develop an overall restoration strategy. A range of alternative strategies will be explored in developing the final strategy, which will incorporate a vision statement for the corridor developed through public and agency consultation as well as specific restoration goals and objectives. Specific restoration actions will be identified, with consideration given to magnitude of the potential benefits, presence of cooperative landowners, and consistency with existing plans and regulations.

Task 3: Develop Conceptual Designs for Five Top Priority Projects. Based on the findings of the technical analyses and the final restoration and monitoring plan, the Project Team will develop conceptual project designs for the five top priority projects. These designs will be used by the stakeholder group to develop "on the shelf" project funding proposals for rapid implementation.

Task 4: Public Workshops. One workshop will be held near the onset of Phase III and one at the end of Phase III to provide information to the broader public beyond the Stakeholder Group.

C. PROJECT LOCATION AND GEOGRAPHIC BOUNDARIES: The baseline evaluations and restoration planning will focus primarily on the 52-mile reach of the Merced River and its floodplain downstream of Crocker-Huffman Dam to the San Joaquin River confluence (Figure 3). In addition, aerial photography and channel mapping (Phase II, Task 3) and vegetation mapping (Phases III, Task 6) will extend upstream to Merced County's eastern boundary (RM 55.5).

D. EXPECTED BENEFITS: This project will provide the framework upon which logical, cost-effective restoration can be based. Implementation of the restoration plan will directly benefit instream aquatic habitat, shaded riparian habitat, seasonally inundated floodplain habitat, and riparian habitat, as well as enhance physical and biological interactions between these habitats. Implementation will also benefit San Joaquin fall-run chinook salmon (a CALFED priority species), migratory birds (a CALFED second priority), and numerous other native species, including several endangered or sensitive species.

Primary stressors that will be addressed by implementation of the restoration plan include: reduced salmon migration barriers and straying, increased spawning gravel supply and transport, reduced salmon predation and competition, improved channel form and processes, improved channel meandering, improved connectivity between channel and functional floodplain, fine sediment deposition on floodplains, and increased riparian corridor width and natural regeneration potential.

The Merced County Planning and Community Development Department regulates aggregate mining in the Merced River and maintains the County General Plan, which defines County land use and resource management policies. The General Plan directs the County to protect, enhance, and restore wetland and riparian areas which provide habitat to rare and endangered species and to ensure that the County's mineral resources are utilized in a way which does not compromise County open space and habitat resources. The project's baseline evaluations and the restoration plan will provide necessary information and guidance to assist the County in future planning and permitting in the Merced River Corridor to minimize impacts of mineral resource development and for pursuing funding to implement specific restoration measures.

E. BACKGROUND AND ECOLOGICAL/BIOLOGICAL/TECHNICAL JUSTIFICATION: The Merced River corridor has been significantly altered by dam construction and operation, flow diversion, gold and aggregate mining, levee construction, and land use conversion. Physical alterations of the Merced River have blocked anadromous fish access to the upper watershed, reduced and degraded habitat for native species, created habitat or increased suitability for introduced predator species, and eliminated or impaired fluvial processes that, under natural conditions, form and maintain riverine habitats and drive ecological processes. CDFG has identified the Merced River as "the most degraded among the San Joaquin tributaries" (Reynolds et al. 1993: p. VII-92). Vick (1995) concluded that without active and large-scale restoration of channel and floodplain morphology and geomorphic processes in the river corridor, salmonid habitat quality will likely continue to decline due to continued channel incision and bed armoring.

Flow in the river is regulated by four mainstem dams (Figure 3), which since 1926 have eliminated the coarse sediment supply from the upper watershed and reduced the 1.5-year flood magnitude by approximately 83% (from 8,260 cfs to 1,420 cfs). In addition, gold and aggregate mining have removed stored bedload from the channel and floodplain downstream of the dams and have substantially altered channel morphology. Vick (1995), in the only large-scale evaluation of the Merced River that has been completed to date, documented channel responses to these perturbations, including reduction in active

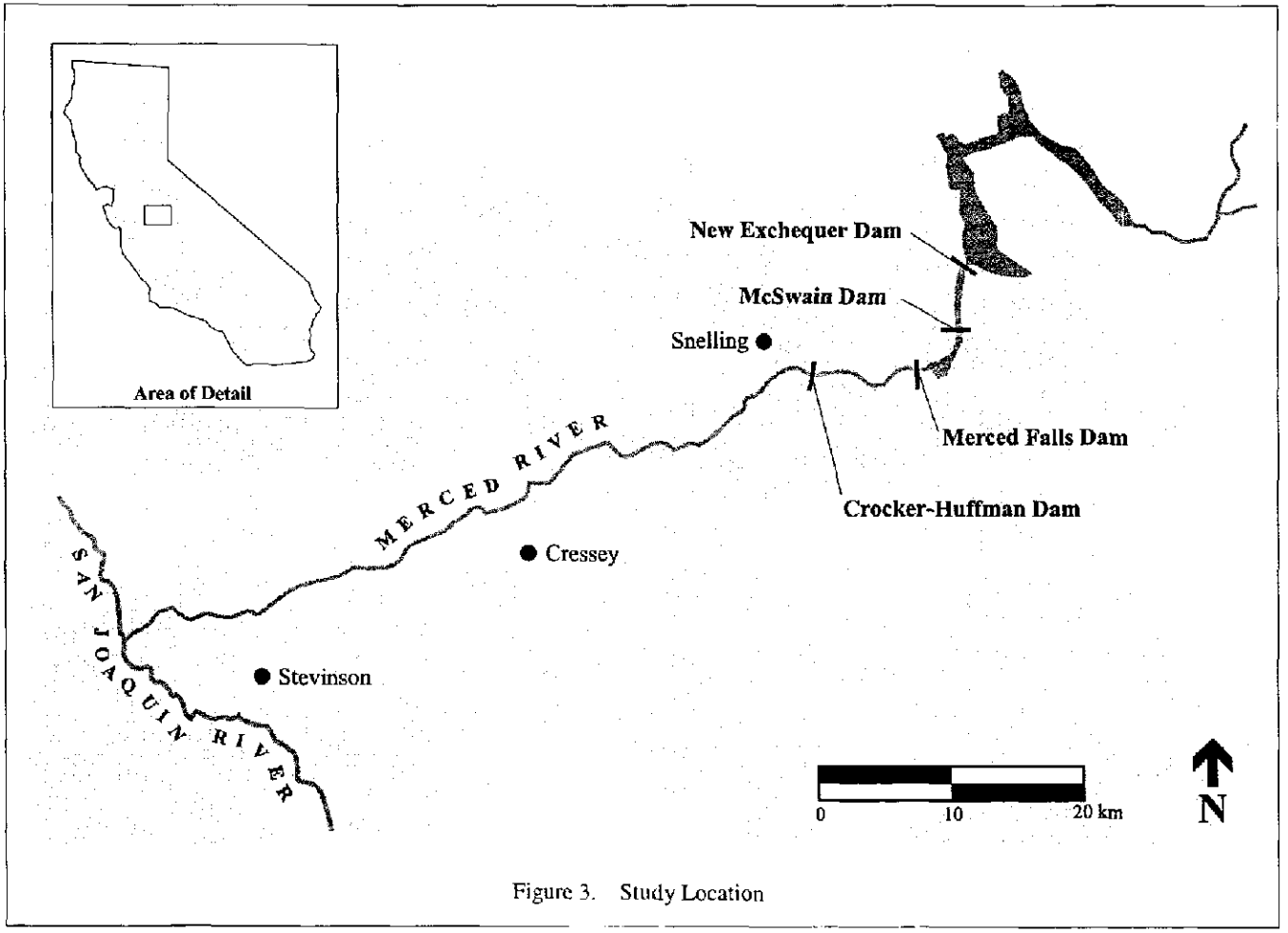

Figure 3. Study Location

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channel width (averaging 85 feet, or 33% of the 1937 channel width), channel incision of up to 20 feet, elimination of channel migration and floodplain slough complexes, and creation of 5.6 miles (273 acres) of instream mining pits that occupy 33% of the historically available spawning reach (Figure 4).

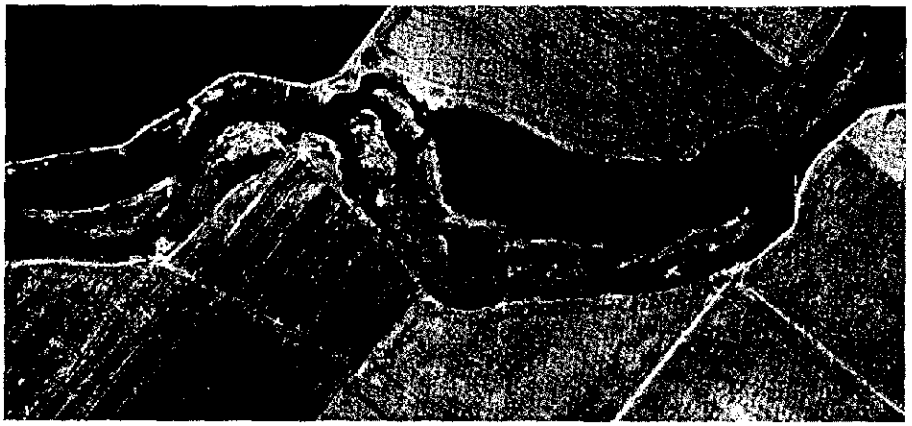
Despite recognition of the degraded condition of the Merced River, no long-term restoration strategy has been developed for this river corridor. Individual habitat restoration and rehabilitation projects have been constructed but have lacked broader consideration of physical processes and geomorphic functions and have generally performed poorly (Kondolf et al. 1996a, 1996b). This project will apply comprehensive understanding of ecological, biological and geomorphic conditions and processes to development of a plan to restore (to the extent feasible) disturbed riverine habitats and to re-establish the fluvial processes necessary for maintaining the system in the long term. This approach, which recognizes the dynamic nature of the fluvial system and linkages between channel, floodplain, and riparian habitats, is emerging as the dominant paradigm in ecological restoration (e.g., National Research Council 1992).

This project will provide necessary baseline information and restoration strategies to address the following ERPP Implementation Objectives: restore basic hydraulic conditions to reactivate and maintain ecological processes that create and sustain habitat required for fish, wildlife, and plant populations (ERPP v. 2, p. 419); provide sufficient quantities of sediment to riverine and estuarine systems to restore or reactivate stream channel meander and point bar formation, provide sediments to build wetlands and shallow water habitats, and provide for nutrient transport (ERPP v. 2, p. 423); improve, maintain, or restore natural stream meander processes to allow natural sediment recruitment, create habitat, and promote riparian succession (ERPP v. 2, p. 424); modify channel and basin configurations to improve floodplain function (ERPP v. 2, p. 427); and restore riparian scrub, woodland, and forest (ERPP v. 2, p. 427).

Implementation of the restoration strategy developed by the project will improve chinook salmon spawning, rearing, and migration conditions. The plan will address the following action and evaluation items identified in the Revised Draft Restoration Plan for the Anadromous Fish Restoration Program: (1) improve watershed management to restore and protect instream and riparian habitat, including consideration of restoring and replenishing spawning gravel (Action Item 3) and (2) evaluate and implement actions to reduce predation on juvenile chinook salmon, including actions to isolate ponded sections of the river (Evaluation Item 3).

F. MONITORING AND DATA EVALUATION: The restoration plan will include river-wide and project-specific monitoring programs to evaluate the effectiveness of the restoration actions. The Project Team is experienced in developing focused, cost-effective and scientifically sound monitoring programs for stream restoration projects, integrated natural resource management plans, and multi-species habitat conservation plans. McBain and Trush and Stillwater Sciences are currently working with the Tuolumne River TAC and AFRP to develop and implement long-term and project-specific monitoring on the Tuolumne River.

G. IMPLEMENTABILITY: Coordination with the Stakeholder Group and TAC throughout the baseline evaluations and restoration planning process are intended to identify and address public, stakeholder, and agency concerns early in the project process and foster a public and stakeholder sense of ownership of the final plan. Recognizing and addressing public and stakeholder issues and concerns early in the process will help to ensure implementability of restoration recommendations. Also, this effort is specifically designed to be coordinated with on-going and planned restoration activities being conducted by CDFG and CDWR in the Merced River corridor.



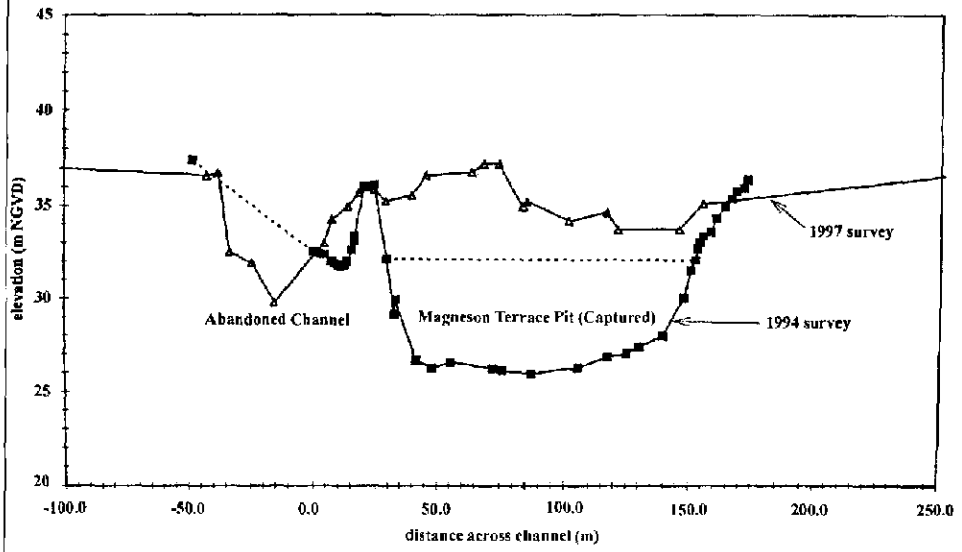


Figure 4. Aerial View and Cross Section of a Typical Captured Mining Pit in the Merced River. Note the 3.5-m increase in depth and three-fold increase in channel width caused by the pit capture.

I-011241

COSTS AND IMPLEMENTATION SCHEDULE

A. BUDGET COSTS

The estimated total cost of Phases I through III of the project is $508,804. The detailed budget is provided in Table 1. Phase I is likely to be funded by AFRP. A funding decision is anticipated in July 1998. The AFRP contact regarding this funding is Rhonda Reed, California Department of Fish and Game, (209) 243-4017. Phases II and III can be funded incrementally; however, incremental funding of tasks included in Phase II may increase project costs by impairing our ability to coordinate field activities for different tasks.

The project would be implemented as a joint venture between Stillwater Sciences and the Merced County Planning and Community Development Department. Stillwater Sciences' (and their subconsultants') financial and technical obligations to the County would be formalized by a Memorandum of Understanding.

B. SCHEDULE MILESTONES

The project schedule indicating milestones and an anticipated meeting schedule is presented in Table 2. Anticipated time to complete the study is 22 months.

Phase I will begin immediately, assuming that funding is provided by AFRP. A Stakeholder Group kick-off meeting is tentatively scheduled for September 1998. Phase II would begin upon approval of CALFED funding. Nonfield-based tasks (Tasks 1, 2, 3, and 4.1) and nonfield-based components of Tasks 4, 5, 6, and 7 would begin immediately upon approval of funding. Field work for geomorphic evaluations requiring high-flow conditions (Tasks 4.3 and 4.4) would begin in winter 1998/99. Field work for geomorphic and ecological evaluations requiring low-flow conditions (Tasks 3 and 6 through 8) would begin in spring/summer 1999. Phase III would begin in November 1999 upon completion of the baseline evaluations.

Stakeholder Group and TAC meetings, TAC field trips, and public workshops are scheduled to coincide with key project milestones (Table 3). Additional, non-milestone TAC meetings are also scheduled to allow continuous communication between the Project Team and the TAC (Table 2).

Payment shall be in arrears on a monthly basis. Stillwater Sciences will invoice on a monthly basis, according to percentage of work completed by task.

C. THIRD PARTY IMPACTS

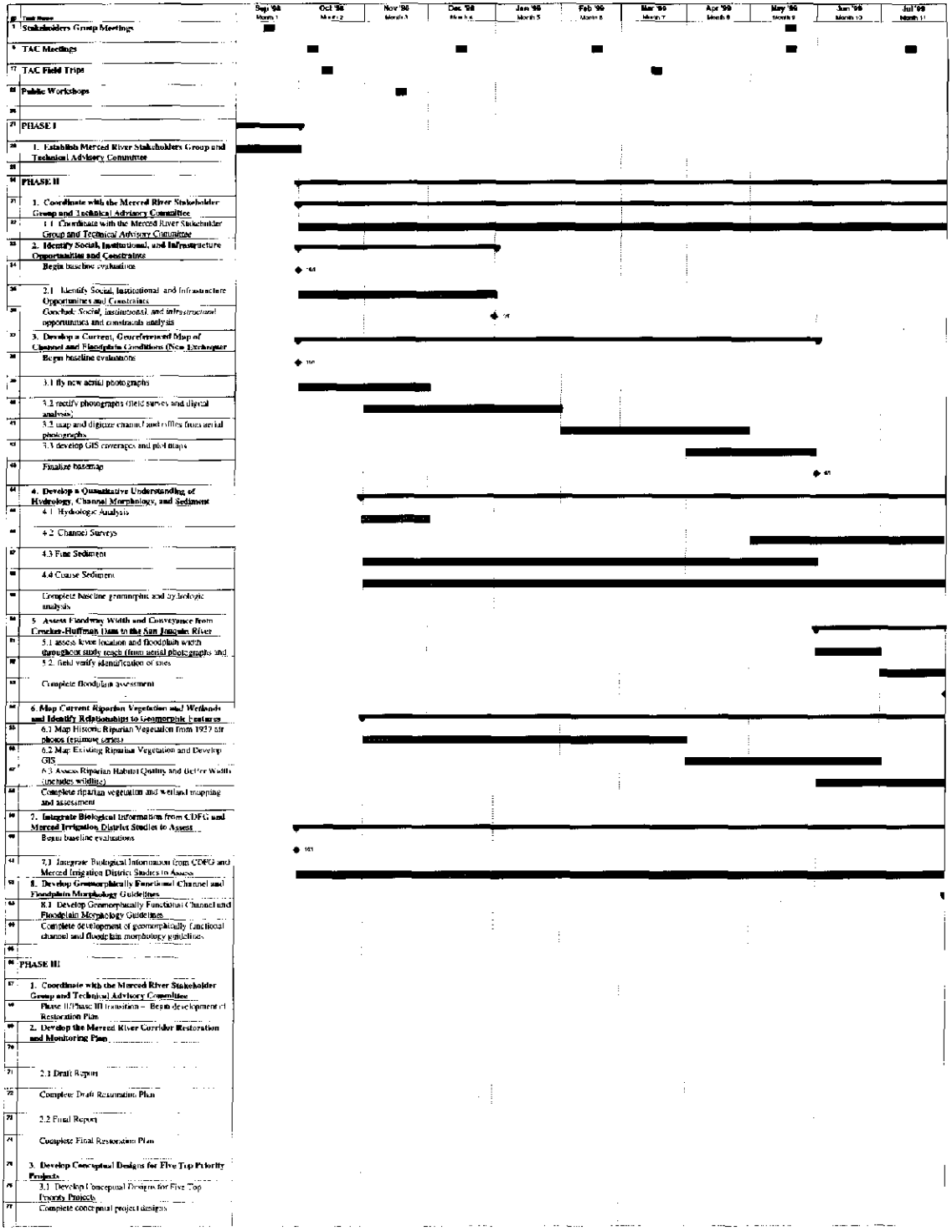
No adverse impacts to third parties are anticipated. The project proposal includes coordination with local landowners, MID, and state and local agencies (via the Stakeholder Group and TAC) to assure that all potential third party impacts are identified and avoided. In addition, all recommended restoration actions will depend on the cooperation of willing landowners.

The project may provide employment opportunities in the area. Plan development and implementation will require a substantial field component, which may provide summer employment, particularly for local students. Project implementation will require transport of required materials and construction.

Table 1. Project Budget

TASK	TOTAL HOURS	DIRECT SALARY AND BENEFITS	OVERHEAD LABOR	MISC. AND OTHER DIRECT COSTS	SERVICE CONTRACTS	MATERIAL AND ACQUISITION CONTRACTS	TOTAL COST
PHASE I: ESTABLISH MERCED RIVER STAKEHOLDER GROUP AND TECHNICAL ADVISORY COMMITTEE	446	$17,982	$7,972	$598	$0	$0	$26,552
PHASE II: BASELINE EVALUATIONS							
1. Coordinate with Merced River Stakeholder Group and Technical Advisory Committee	264	$6,572	$9,068	$500	$0	$0	$16,140
2. Identify Social, Institutional, and Infrastructure Opportunities and Constraints	380	$9,500	$17,861	$500	$0	$0	$27,861
3. Develop Current, Georeferenced Map of Channel and Floodplain Conditions	558	$14,338	$17,920	$3,041	$8,500	$0	$43,800
4. Develop Quantitative Understanding of Hydrology, Channel Morphology, and Sediment Supply and Transport							
4.1. Hydrologic Analysis	50	$1,670	$2,112	$0	$0	$0	$3,783
4.2. *Channel Surveys*			*costs included in tasks 4.3, 4.4, and 8*				
4.3. Fine Sediment Sources to the Spawning Reach	170	$5,441	$6,319	$143	$0	$0	$11,903
4.4. Coarse Sediment	832	$23,623	$27,257	$6,270	$0	$0	$57,250
5. Assess Floodway Width and Conveyance from Crocker-Huffman Dam to the San Joaquin River	143	$4,685	$5,627	$281	$0	$0	$10,793
6. Map Current Riparian Vegetation and Wetlands and Identify Relationships to Geomorphic Features and Processes	1,100	$26,915	$26,341	$4,491	$0	$0	$57,746
7. Integrate Biological Information form CDFG and MID Studies to Assess Ecological Conditions	400	$11,713	$15,667	$2,500	$0	$0	$29,880
8. Develop Geomorphically Functional Channel and Floodplain Morphology Design Guidelines	*1,358*	*$28,617*	*$32,899*	*$0,182*	*$0*	*$0*	*$70,879*
9. Public Workshop (One)	64	$1,628	$2,703	$500	$0	$0	$4,831
Project Management (5% of total)	155	$8,153	$4,200	$0	$0	$0	$12,353
PHASE III: DEVELOP MERCED RIVER CORRIDOR RESTORATION AND MONITORING PLAN							
1. Coordinate with Merced River Stakeholder Group and Technical Advisory Committee	116	$3,778	$6,582	$500	$0	$0	$10,860
2. Develop Merced River Corridor Restoration and Monitoring Plan	1012	$30,309	$36,359	$2,735	$0	$0	$69,403
3. Develop Conceptual Designs for Five Top Priority Projects	*388*	*$12,389*	*$12,607*	*$0*	*$0*	*$0*	*$25,086*
4. Public Workshops (Two)	128	$3,256	$6,406	$1,000	$0	$0	$9,662
Project Management (5% of total)	59	$3,119	$1,607	$0	$0	$0	$4,725
Scientific Advisory	120	$0	$0	$0	$15,300	$0	$15,300
TOTAL							
Phase I	**446**	**$17,982**	**$7,972**	**$598**	**$0**	**$0**	**$26,552**
Phase II	**5,112**	**$143,055**	**$168,273**	**$27,389**	**$8,500**	**$0**	**$347,217**
Phase III	**1,706**	**$52,850**	**$62,550**	**$4,235**	**$0**	**$0**	**$119,735**
Scientific Advisory	***120***	**$0**	**$0**	**$0**	**$15,300**	**$0**	**$15,300**

TABLE 2: PROJECT SCHEDULE



	Task Name
1	**Stakeholders Group Meetings**
9	**TAC Meetings**
17	**TAC Field Trips**
25	**Public Workshops**
26	
27	**PHASE I**
28	**1. Establish Merced River Stakeholders Group and Technical Advisory Committee**
29	
30	**PHASE II**
31	**1. Coordinate with the Merced River Stakeholder Group and Technical Advisory Committee**
32	1.1 Coordinate with the Merced River Stakeholder Group and Technical Advisory Committee
33	**2. Identify Social, Institutional, and Infrastructure Opportunities and Constraints**
34	Begin baseline evaluation
36	2.1 Identify Social, Institutional and Infrastructure Opportunities and Constraints
39	*Conclude: Social, institutional, and infrastructural* opportunities and constraints analysis
37	**3. Develop a Current, Georeferenced Map of Channel and Floodplain Conditions (New Exchequer**
38	Begin baseline evaluations
39	3.1 fly new aerial photographs
40	3.2 rectify photographs (field survey and digital analysis)
41	3.3 map and digitize channel and riffles from aerial photographs
42	3.3 develop GIS coverages and plot maps
43	Finalize basemap
44	**4. Develop a Quantitative Understanding of Hydrology, Channel Morphology, and Sediment**
45	4.1 Hydrologic Analysis
46	4.2 Channel Surveys
47	4.3 Fine Sediment
48	4.4 Coarse Sediment
49	Complete baseline geomorphic and hydrologic analysis
50	**5. Assess Floodway Width and Conveyance from Crocker-Huffman Dam to the San Joaquin River**
51	5.1 assess river location and floodplain width throughout study reach (from aerial photographs and
52	5.2. field verify classification of sites
53	Complete floodplain assessment
54	**6. Map Current Riparian Vegetation and Wetlands and Identify Relationships to Geomorphic Features**
55	6.1 Map Historic Riparian Vegetation from 1927 air photos (estimate series)
56	6.2 Map Existing Riparian Vegetation and Develop GIS
57	6.3 Assess Riparian Habitat Quality and Better Width (includes wildlife)
58	Complete riparian vegetation and wetland mapping and assessment
59	**7. Integrate Biological Information from CDFG and Merced Irrigation District Studies to Assess**
60	Begin baseline evaluations
61	7.1 Integrate Biological Information from CDFG and Merced Irrigation District Studies to Assess
62	**8. Develop Geomorphically Functional Channel and Floodplain Morphology Guidelines**
63	8.1 Develop Geomorphically Functional Channel and Floodplain Morphology Guidelines
64	Complete development of geomorphically functional channel and floodplain morphology guidelines.
65	
66	**PHASE III**
67	**1. Coordinate with the Merced River Stakeholder Group and Technical Advisory Committee**
69	Phase II/Phase III transition – Begin development of Restoration Plan
69	**2. Develop the Merced River Corridor Restoration and Monitoring Plan**
70	
71	2.1 Draft Report
72	Complete Draft Restoration Plan
73	2.2 Final Report
74	Complete Final Restoration Plan
75	**3. Develop Conceptual Designs for Five Top Priority Projects**
76	3.1 Develop Conceptual Designs for Five Top Priority Projects
77	Complete conceptual project designs

TABLE 2: PROJECT SCHEDULE

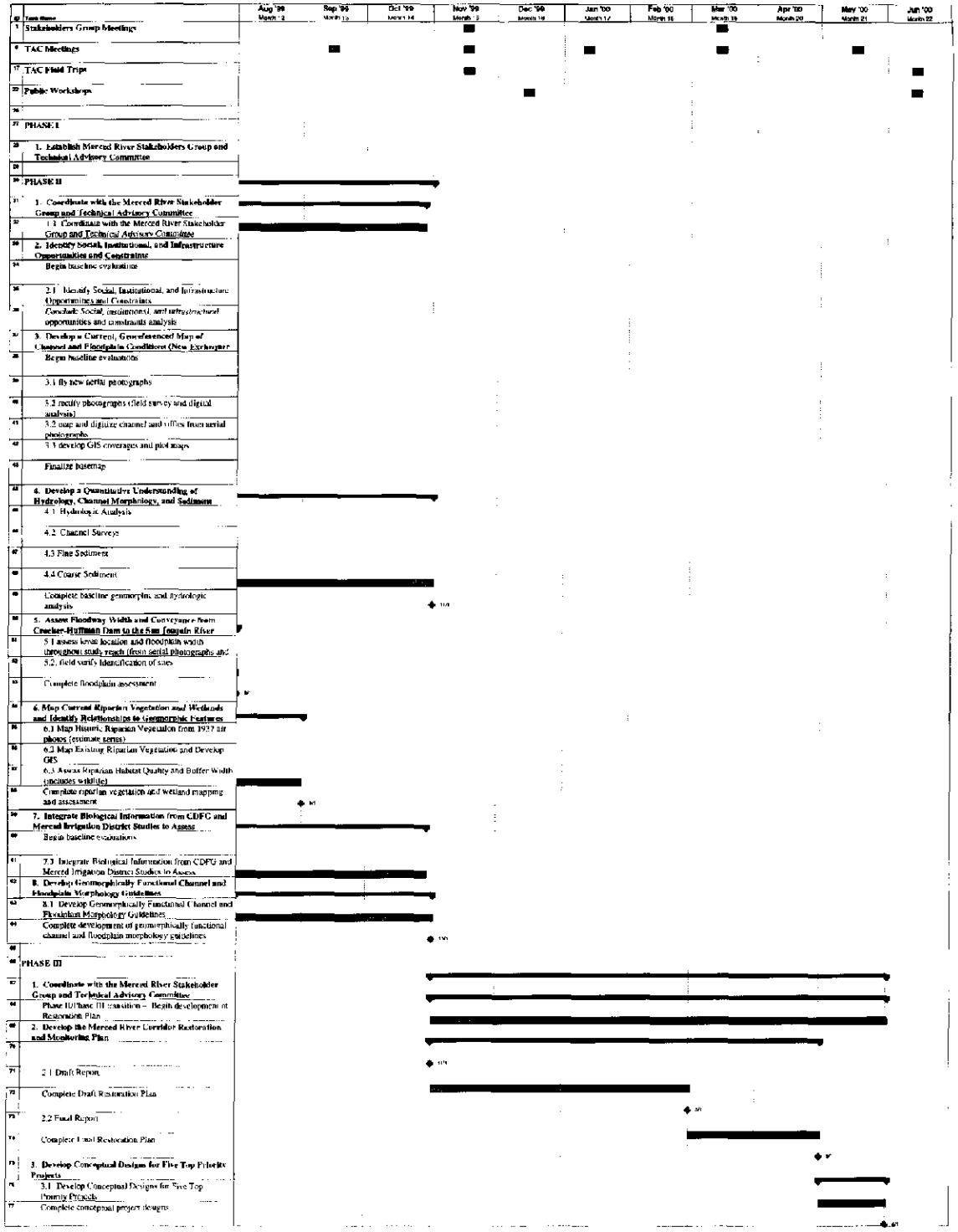


Table 3. Milestone Schedule and Anticipated Milestone Meetings

Milestone	Anticipated Date	Related Milestone Meeting
Begin baseline evaluations	October 1998	Stakeholder Group TAC meeting and field trip Public Workshop
Conclude social, institutional, and infrastructural opportunities and constraints analysis	December 1998	TAC
Finalize basemap	May 1999	Stakeholder Group TAC
Complete baseline geomorphic and hydrologic analysis	September 1999	TAC
Complete floodplain assessment	July 1999	TAC
Complete riparian vegetation and wetland mapping and assessment	August 1999	TAC
Complete development of geomorphically functional channel and floodplain morphology guidelines	October 1999	carried over to November meetings
Phase II/Phase III transition – Begin development of Restoration Plan	November 1999	Stakeholder Group TAC meeting and field trip Public Workshop
Complete draft Restoration Plan	January 2000	Stakeholder Group TAC
Complete final Restoration Plan	April 2000	carried over to May meetings
Complete conceptual project designs	May 2000	TAC Public Workshop

APPLICANT QUALIFICATIONS

PROJECT TEAM STRUCTURE: The Project Team consists of the Merced County Planning and Community Development Department, three consulting firms (Stillwater Ecosystem, Watershed & Riverine Sciences, Inc.; McBain and Trush; EDAW, Inc.), and a Scientific Advisory Team. The County will act as the local lead and will coordinate the Technical Advisory Committee. As the local lead, the County will conduct public outreach and hold public workshops. Stillwater Sciences will be the contractee and will manage the project. McBain and Trush and EDAW will be subcontractors to Stillwater Sciences. A lead management team will be composed of members of the County and the three firms: Robert Smith (Merced County), Frank Ligon (Stillwater Sciences), Jennifer Vick (Stillwater Sciences), Scott McBain (McBain and Trush), and Bruce DiGennaro (EDAW). The team leaders will be supported by experienced staff members, most of whom have extensive experience in the San Joaquin Basin. Not all staff members who will be participating in this project are identified in this proposal. (Resumes of team leaders and staff can be provided upon request.)

The Project Team has extensive experience in public coordination and facilitation and ecological, geomorphic, and environmental management issues in the San Joaquin Basin. In addition, the three consulting firms have worked together for several years on projects on the Tuolumne River. Projects completed or underway by team members include: a comprehensive, ten-year analysis of chinook salmon population dynamics and factors limiting production in the Tuolumne River (see Appendix B); an analysis of geomorphic conditions in the Merced River (Vick 1995; Kondolf et al. 1996); a large-scale, process-based restoration plan for the Tuolumne River (McBain and Trush 1998); planning and design for site-specific restoration projects on the Tuolumne and Merced rivers; and monitoring and evaluation of implemented restoration projects on the Tuolumne, Stanislaus, and Merced rivers. Also, EDAW (with Stillwater Sciences as the biological resources subcontractor) recently completed the NEPA/CEQA documentation for implementing two large restoration projects on the Tuolumne River.

The scientific advisory team, which consists of internationally recognized experts in the fields of geomorphology, hydrology, aquatic and riparian ecology, and statistics, will provide input to study design, data analysis, and development of the restoration strategy. (CVs for the scientific advisory team can be provided upon request.)

MERCED COUNTY PLANNING AND COMMUNITY DEVELOPMENT DEPARTMENT: The Merced County Planning and Community Development Department (the County) advises the County Planning Commission and Board of Supervisors on a wide range of development and resource management issues affecting unincorporated areas of Merced County and maintains the County General Plan. The County has extensive experience in facilitating a wide range of groups and committees, including facilitating input from local and state agencies, interest groups, and local municipal advisory councils to development proposals to ensure that the needs of these widely ranging interests are considered; facilitating a school mitigation fee agreement for legislative acts which affect the adequacy of school facilities; and facilitating agreements between the County and the unincorporated cities for annexations. The County is also directly involved in the joint planning process with the University of California and others to develop a vision for an 11,000-acre area which includes the site for the tenth University of California campus and supporting land uses.

Robert Smith (Project Manager, Merced County): Mr. Smith has been the Planning and Community Development Director for Merced County since 1986. Prior to joining Merced County, Mr. Smith was the Planning and Community Development Director for the City of Ceres. He received his undergraduate degree in City and Regional Planning from California Polytechnic State University. He has been involved in a wide range of development issues at both municipal and regional levels and has had

extensive experience working with local agencies, such as the Merced Irrigation District, and local landowners on a variety of development, water, and land use issues.

STILLWATER SCIENCES: Stillwater Sciences is a firm of biological, ecological, and geological scientists. The company specializes in developing new scientific approaches and technologies for problem-solving in aquatic and terrestrial systems and has extensive experience and in-house ability in GIS applications to environmental analyses. Its founding members have over fifty years of experience in freshwater ecology, fisheries and wildlife biology, riparian and wetland ecology, entomology, botany, and hillslope and fluvial geomorphology. Recent projects include impact assessment and restoration of rivers affected by hydroelectric dams, timber harvest, and irrigation in California and the Pacific Northwest. Stillwater Sciences will provide project direction and management and will lead in Phase II Tasks 1 and 7 and Phase III Tasks 1 and 2 and co-lead with McBain and Trush in Phase II Tasks 3, 4, and 5.

Frank Ligon (Project Director, Aquatic Habitat Assessment Team Leader): Mr. Ligon is an aquatic ecologist and geomorphologist specializing in investigations of the role of fluvial processes and morphology in the ecology of stream fish, invertebrates, and plant communities. He has successfully managed several complex, long-term projects involving watershed analysis, salmon ecology and restoration, geomorphology and riverine ecosystem restoration. His Central Valley experience includes managing a ten-year chinook salmon ecology and restoration project on the Tuolumne River below New Don Pedro Dam (see Appendix B).

Jennifer Vick (Project Manager, Geomorphic Analysis and Floodplain Assessment Team Co-leader): Ms. Vick is an aquatic ecologist and geomorphologist. Her experience ranges from microhabitat partitioning of fishes to geomorphic and hydrologic impacts of dams. She conducted her masters research on the Merced River, including extensive field surveys and coordination with state and local agencies, MID, and local landowners in the Merced River corridor.

MCBAIN AND TRUSH: McBain and Trush is a professional consulting partnership applying fluvial geomorphic and ecological research to river preservation, management, and restoration. Their primary goals are maintaining or attaining river ecosystem health in regulated rivers, nationally and internationally; assessing impacts of land use activities on stream ecosystems; and recommending management strategies to minimize or eliminate negative impacts to those ecosystems. McBain and Trush has considerable experience in river corridor restoration, including: Mono Basin Stream Restoration Work Plan, Maintenance Flow Study on the Trinity River, and the Tuolumne River Corridor Restoration Plan. McBain and Trush will lead in Phase II Task 6 and Phase III Task 3 and co-lead with Stillwater Sciences in Phase II Tasks 3, 4, and 5.

William Trush (Riparian and Wetland Assessment and Restoration Design Team Leader): Dr. Trush is a geomorphologist and ecologist specializing in anadromous fish ecology, anadromous fish interactions with fluvial geomorphology and hydrology, channel maintenance flows, riparian ecology, macrobenthic invertebrate ecology, and stream restoration. In addition to his work with McBain and Trush, Dr. Trush is an adjunct professor in the Humboldt State University Fisheries Department, where he teaches stream ecology and coastal stream management, and is Director of the Humboldt State University Institute for River Ecosystems.

Scott McBain (Geomorphic Analysis and Floodplain Assessment Team Co-leader): Mr. McBain is an assistant hydraulic engineer/fluvial geomorphologist whose interests include bed mobility, bedload transport, effects of high flows on channel morphology, watershed sediment yields, and stream restoration. He has worked extensively on the Tuolumne River, including the development of the Tuolumne River Corridor Restoration Plan.

EDAW, INC.: EDAW is an international consulting firm specializing in environmental compliance and land use planning. EDAW has directed and managed numerous large-scale watershed planning and resource management assignments in California and is recognized for its ability to integrate technical information into effective policy planning. Recent river restoration projects include: the Lower Mokelumne River Management Plan; the Salinas Basin Management Plan; CEQA/NEPA compliance for the Upper Truckee River Restoration Project; and preparation of a programmatic EIR/EIS involving restoration of the lower American River. EDAW will provide support to the County to complete Phase II, Task 2 and support the County in coordinating and holding public workshops.

Bruce DiGennaro (Public Coordination Social/Institutional Opportunities and Constraints Team Leader): Mr. DiGennaro is an environmental planner with over 12 years of experience developing river management plans. He has been involved in studies on the Tuolumne, Mokelumne, and Stanislaus rivers in central California and the Sacramento, Klamath, Feather, and Trinity rivers in northern California. He is currently working with several agricultural and urban water agencies in on anadromous fish restoration planning activities in the Sacramento-San Joaquin Delta.

SCIENTIFIC ADVISORY TEAM

William Dietrich (fluvial geomorphology): Dr. Dietrich is a professor in the Department of Geology and Geophysics, University of California, Berkeley. Dr. Dietrich's research has been instrumental in the development of the watershed analysis methodologies that are now being used to guide much of the planning effort for the restoration of Pacific salmon. Much of his recent work has focused on the downstream effects dams and land use on fluvial systems, including the linkages between physical processes and aquatic biota and the development of methods for restoring degraded rivers.

Richard Harris (riparian ecology): Dr. Harris is an extension forestry specialist in the Department of Environmental Science, Policy and Management, University of California, Berkeley. His primary areas of research expertise are the ecology, monitoring, and restoration of riparian communities, Native American natural resource management, and the relationships between riparian vegetation and fluvial geomorphology in the Central Valley.

Mary Power (aquatic ecology): Dr. Power is a professor in the Department of Integrative Biology, University of California, Berkeley with over 40 published articles on freshwater ecology, food web analysis, and fish biology. Much of her recent work focuses on the effects of natural and human disturbances on aquatic biodiversity and food web interactions. Dr. Power is the senior author of a paper on sustaining aquatic food webs that is included in a recent report to the Western Water Policy Review Presidential Advisory Commission.

Terence Speed (statistics): Dr. Speed is a professor, and former chair, in the Department of Statistics, University of California, Berkeley. He has published over 100 papers, including papers on the influence of temperature on the survival of chinook salmon smolts and modeling and managing a salmon population, which were based on work conducted in the Tuolumne River. Dr. Speed has contributed his expertise to a wide range of applied statistics problems, including models of fisheries population dynamics.

COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The applicants have reviewed and are able to comply with the terms and conditions set forth in Attachment D of the Request for Proposals. No additional forms are required for submittal under Category G.

APPENDIX A.

LITERATURE CITED

I-011251

REFERENCES:

CDWR (California Department of Water Resources). 1994. San Joaquin River tributaries spawning gravel assessment: Stanislaus, Tuolumne, and Merced rivers. Memorandum Report. CDWR, Northern District, Red Bluff.

JSA (Jones and Stokes Associates, Inc.). 1995. Temperature and gravel investigations for fisheries enhancement on the lower Merced River, Merced County, California. Prepared for California Department of Fish and Game, Environmental Services Division, Sacramento.

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Kondolf, G. M., J. C. Vick, and T. M. Ramirez. 1996b. Salmon spawning habitat rehabilitation on the Merced River, California: an evaluation of project planning and performance. Transactions of the American Fisheries Society 125: 899-912.

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National Research Council. 1992. Restoration of aquatic ecosystems. National Academy Press, Washington, D. C.

USFWS (U. S. Fish and Wildlife Service). 1997. Identification of the instream flow requirements for fall-run chinook salmon spawning in the Merced River. USFWS, Instream Flow Assessments Branch, Ecological Services Office, Sacramento, California.

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Wilcock, P.R. 1997. A method for predicting sediment transport in gravel-bed rivers. Johns Hopkins University, Baltimore MD.

WEST Consultants, Inc. 1995. Sedimentation and fish habitat—Merced River. Draft report. Seattle, Washington.

APPENDIX B.

TUOLUMNE RIVER STUDY BIBLIOGRAPHY

TUOLUMNE RIVER STUDY BIBLIOGRAPHY

Reports prepared in whole or in part by Frank Ligon while employed at EA Engineering and managing the Tuolumne River chinook salmon ecology and restoration project. All are appendices to: Don Pedro Project Fisheries Studies Report (FERC Article 39, Project No. 2299). *In* Report of Turlock Irrigation District and Modesto Irrigation District Pursuant to Article 39 of the License for the Don Pedro Project, No. 2299. EA, Lafayette, California.

Appendix 1: San Joaquin River system chinook salmon population model documentation and validation. 1991.
Appendix 2: Stock-recruitment analysis of the population dynamics of San Joaquin River system chinook salmon. 1992.
Appendix 3: Tuolumne River salmon spawning surveys 1971-1988. 1991.
Appendix 5: Analysis of 1981 lower Tuolumne River IFIM data. 1991.
Appendix 6: Lower Tuolumne River spawning gravel availability and superimposition. 1992.
Appendix 7: Lower Tuolumne River chinook salmon redd excavation report. 1991.
Appendix 8: Lower Tuolumne River spawning gravel studies report. 1991.
Appendix 9: Spawning gravel cleaning methodologies. 1991.
Appendix 10: 1987 Juvenile chinook salmon mark-recapture study. 1991.
Appendix 11: An evaluation of the effect of gravel ripping on redd distribution in the lower Tuolumne River. 1991.
Appendix 12: Data reports: seining of juvenile chinook salmon in the Tuolumne, San Joaquin, and Stanislaus rivers, 1986-1989. 1991.
Appendix 13: Preliminary juvenile salmon study: Report on sampling of chinook salmon fry and smolts by fyke net and seine in the lower Tuolumne River 1973-1986. 1991.
Appendix 14: Tuolumne River fluctuation flow study report. 1991.
Appendix 15: Tuolumne River fluctuation flow study plan: Draft. 1992.
Appendix 16: Aquatic invertebrate studies report. 1991.
Appendix 17: Preliminary Tuolumne River water temperature report. 1991.
Appendix 18: Lower Tuolumne River instream temperature model documentation: Description and calibration. 1991.
Appendix 19: Modeled effects of La Grange releases on instream temperatures in the lower Tuolumne River. 1991.
Appendix 20: Juvenile salmon pilot temperature observation experiments. 1991.
Appendix 21: Possible effects of high water temperature on migrating chinook salmon (*Oncorhynchus tshawytscha*) smolts in the San Joaquin River. 1991.
Appendix 22: Lower Tuolumne River predation study report. 1992.
Appendix 23: Effects of turbidity on bass predation efficiency. 1991.
Appendix 24: Effects of introduced species of fish in the San Joaquin River system. 1991.
Appendix 26: Export mortality fraction submodel. 1992.
Appendix 27: Tuolumne River summer flow study report 1988-1990. 1991.
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